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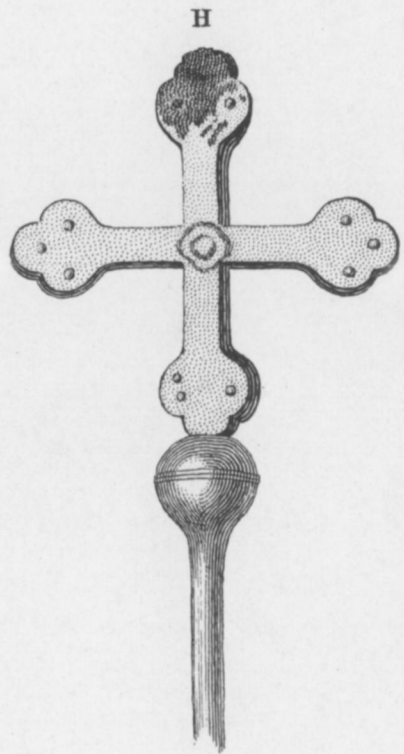
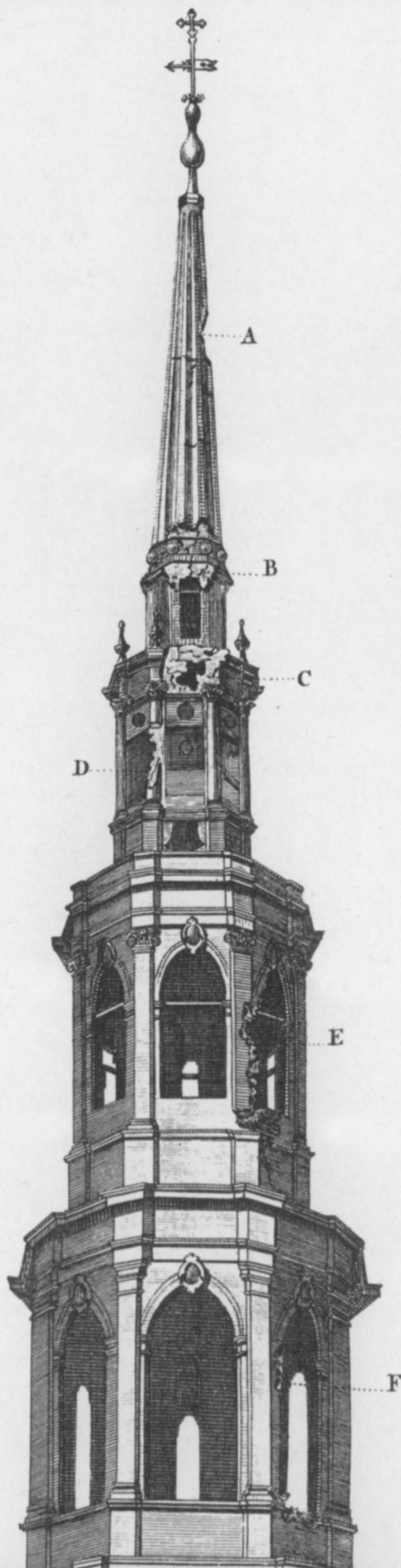
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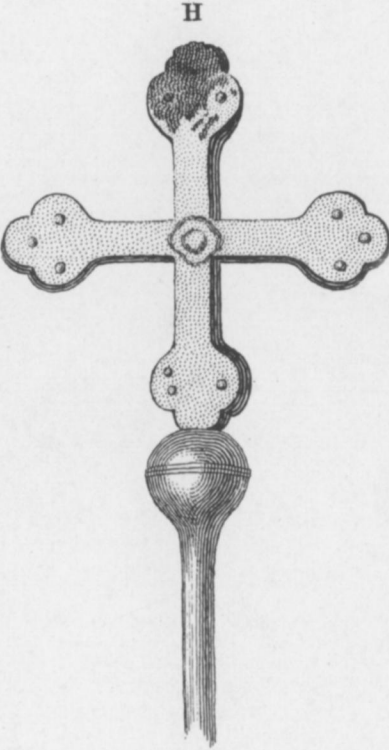
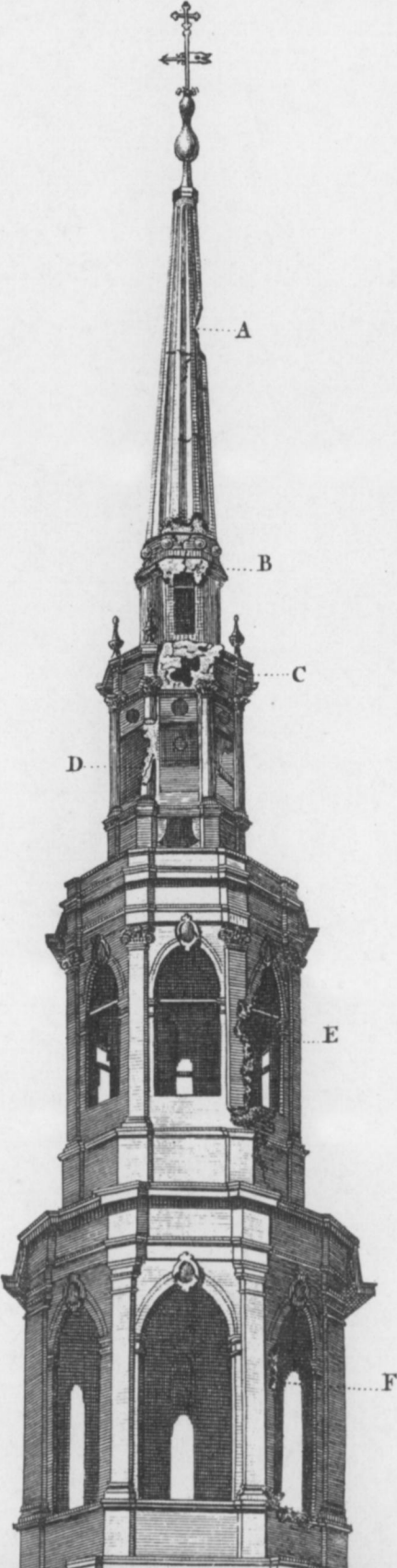
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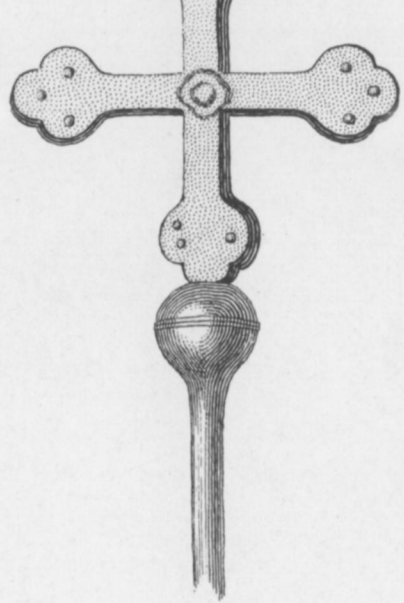
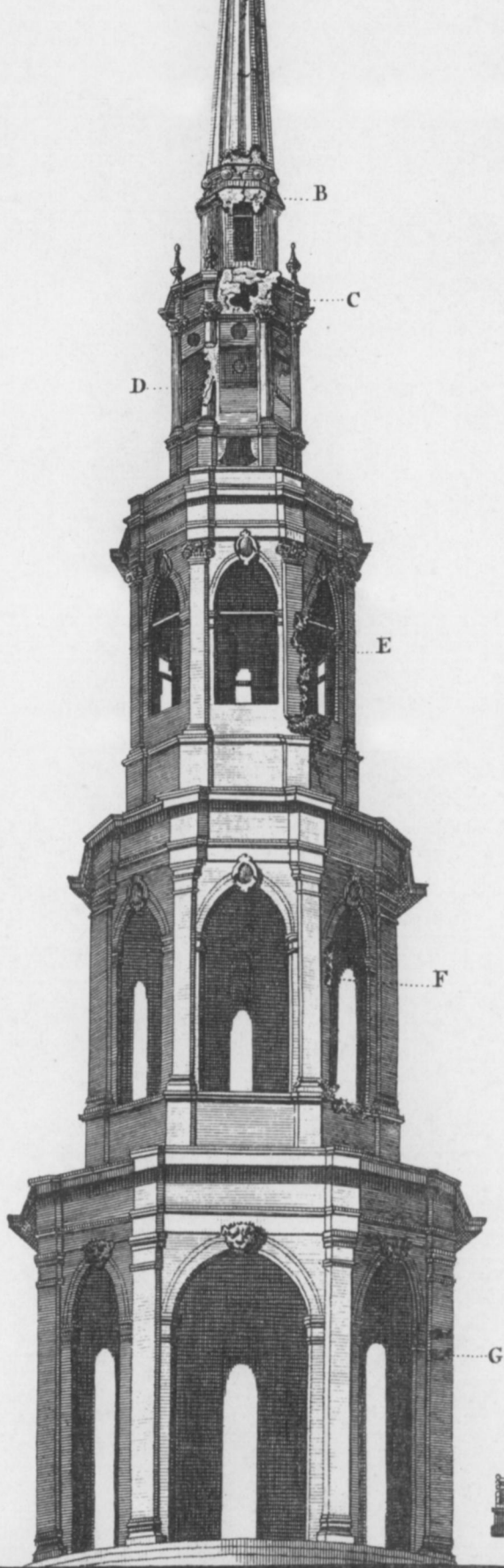
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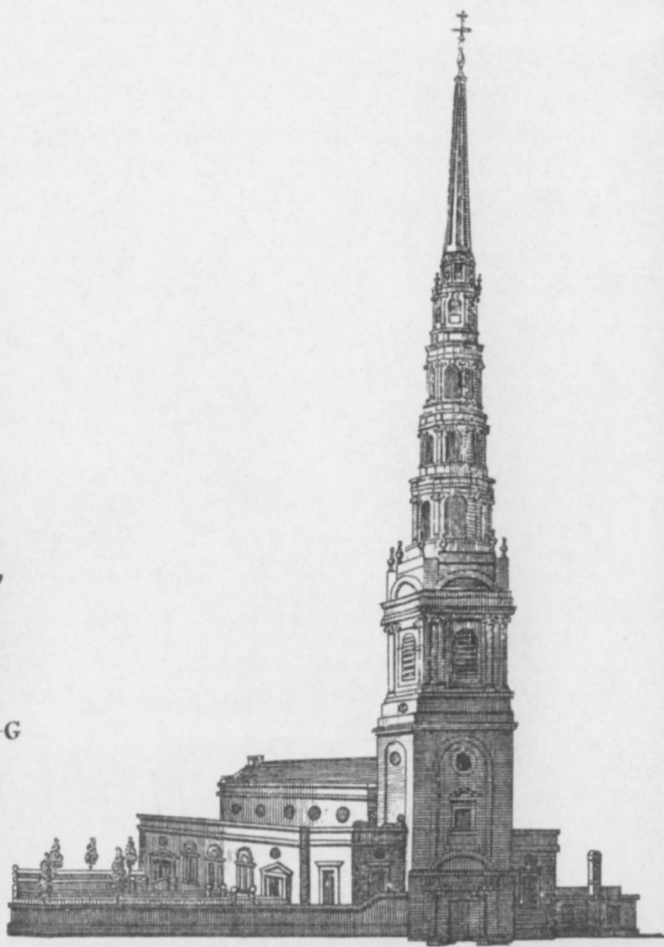
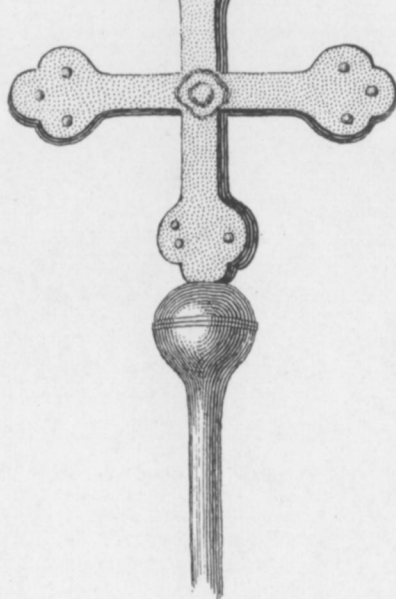
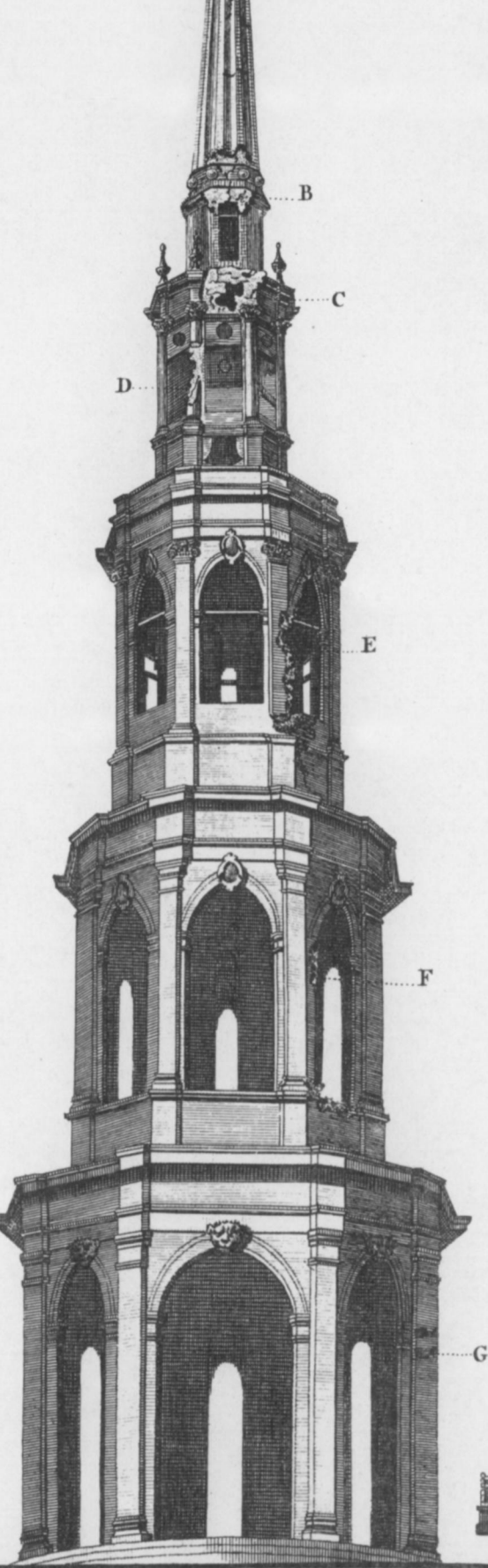
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my answers to them, as a testimony of the very great esteem and regard, with which I am,

My Lord,

Your Lordship's

most obedient,

humble servant,

Lincoln's Inn-Fields,
June 26th, 1764.

W. Watfon.

XLI. *An Account of the Effects of Lightning in St. Bride's Church, Fleet-street, on the 18th of June 1764: In a Letter to Mr. Benjamin Wilfon, F. R. S. from Edward Delaval Esq; F. R. S.*

S I R,

Read June 28, 1764. **T**HE inclosed is an account of the effects of the lightning on the steeple and spire of St. Bride's church, with drawings [TAB. XIV. XV.] which very accurately express the parts damaged by it.

I thought it would be of use, by describing the several circumstances of this accident, to shew more

fully the necessity of preventing the danger, that such buildings are exposed to.

The construction of the spire is somewhat similar to that of an apparatus purposely contrived to draw the lightning from the clouds, as it runs up towards a point, and ends in a metal vane and cross, the figure of which, as well as the materials that they consist of, seem calculated to admit the lightning with the least resistance.

At this place the first marks of it are seen: at H the top of the copper cross, which is the highest part of the building, the gilding is by the explosion partly torn off and partly discoloured, so as to differ remarkably from the rest of the cross where the gilding is very well preserved. Some small pieces of solder are melted; and all this part appears as if it had been exposed to the fire.

The lightning seems to have entered here, and to have been conducted as low as the hole at A, by an iron spindle twenty feet in length, and two inches in diameter; of which ten feet were surrounded by the copper ball, vane and cross; and the lower half was inclosed in a groove cut through the middle of the solid stones which composed the upper part of the spire, and rested at A on the bottom of that groove, which was sunk five inches deep into the lowest of those solid stones: this last mentioned stone being three feet broad and one deep. The interval between the sides of the spindle and the groove made to receive it was filled up by melted lead poured in between them.

The lightning accumulated in the metal, having its passage towards the earth strongly resisted at this place, has in expanding itself formed the hole A, by
burst-

bursting off from the lower part of the spindle the stones contiguous to it on that side.

At each of the angles of the metal, the stone on which it rested is cracked, which probably was occasioned by the lightning issuing with greater freedom from those parts, than from the flat surface.

No part of the spindle is in the least injured by the lightning, notwithstanding the great quantity which, from it's effects, appears to have been accumulated in it *.

From hence, as low as to the corniche B, it seems to have been conducted along the surface of the spire, which was wetted by the rain that had fallen in the morning, before the lightning: and having been accumulated in the iron bars B and C, in discharging itself from them, it has made the greatest explosion at this place.

Under this part the freedom of it's passage seems to have been hindered by all the dry stonework underneath, which was defended from the rain by the corniches: and it appears from some experiments which I formerly made †, that dry free stone, when warm'd to a certain degree (which probably does not exceed the heat which the stones of buildings acquire in hot weather) resists the passage of the electric fluid or lightning so strongly, that with plates of that stone, instead of glass, I performed the Leyden experiment.

* In the year 1750 the stones surrounding this spindle were so much damaged, that there was a necessity of taking them down and rebuilding that part of the spire. The cause of this was not known at that time, it is probable that it was occasioned in the same manner as the present accident.

† Philosophical Transactions, anno 1759. p. 83.

Under the cornice, the lightning descended only by leaping from one iron to another; and at every leap its force seems to have been weakened, and at last to have been quite dissipated.

On examining the inside of the steeple beginning from the top, the first effect of the lightning that appears is a hole in the stone work at B, beginning immediately above an iron bar which served to support the top of the window or opening, and running upwards towards the two cross iron bars: this, when viewed from the outside of the church, is seen to have spread round most of the lower part of the spire, so that it seems in great danger of falling.

The next stroke is about four feet below: at this place four iron bars lie horizontally across the spire, and are tied together by chain bars which are inclosed in the stonework: where the end of one of the cross bars is inserted in the stone, the lightning has burst open the hole described at C, and, when the same is viewed at the outside, a great part of the cornice appears to be broken off.

At D, where the two iron bars serving to support the top of the windows meet and are joined together, the lightning accumulated in them has broken off the pier by which they were inclosed.

At Fig 2, a bar of iron, which served to support the top of the window in the same manner as those last mentioned, 21 inches long clear of the stonework, and half an inch thick, is broke and bent into the position expressed in the drawing; and the stones immediately above it are shattered and disjointed.

The fills of two windows of this story are torn off from iron bars which lay beneath them.

At

At E, an iron bar N°. 1. about twenty five inches long, was inclosed nine inches deep in the stonework of the pier, separating the East arch from the arch next it towards the North: the end of this bar joins at a right angle another bar, N°. 2, which is laid across the arch. The lightning accumulated in the iron (N°. 1.) which was inclosed in the stonework, has burst off all the stone that surrounded it, and part of the pier adjoining. The flaw is continued downwards, as expressed in the drawing, meeting with smaller iron cramps in it's way.

At F, the next arch lying immediately under the last mentioned one, an iron was inclosed in the stone in the same manner as the bar at N°. 1. The stone is torn off from this iron exactly in the same manner as at N°. 1: but the damage has not reached much further than the stone which was contiguous to and covered this bar. At the bottom of this arch the fill stone, which covered some cramps of iron, is torn off from it's place.

At G, the next arch under this, the force of the lightning seems to have been much diminished, a small part of one stone only being broken.

From the wall at the West side of the South window of the belfry some stones are thrown down: one chalky stone in particular is reduced into an impalpable powder, and the wall under the West window is almost covered with the powder: this stroke seems to have been directed towards the bells one of which is very near the place damaged: the bells have not been examined; nor can they, as I am informed, without danger of shaking the spire by their motion.

This

This is the lowest mark which is left of the effects of the lightning.

In every part that is damaged, the lightning has acted as an elastic fluid, endeavouring to expand itself where it was accumulated in the metal: and the effects are exactly similar to those which would have been produced by gun-powder pent up in the same places, and exploded. Amongst many other stones thrown to a considerable distance by these explosions, one weighing above seventy pounds was removed fifty yards Eastward from the steeple, where it fell through the roof of a house.

It is evident that these effects would have been prevented, if a sufficiently large metallic conductor had been extended from the metal at the top of the spire down to the earth, communicating with the other metallic parts of the building that lay in its way.

From several observations which I made on this occasion, such a communication seems necessary in buildings of this form. The iron bars, which were fixed in the stonework of the East arches were struck by the lightning, while those in the arches fronting them on the West side of the same story remained untouched by it. So that I do not apprehend, that a conductor communicating with the West arches only, would have preserved the opposite ones from the damage which they have suffered.

When such buildings are exposed to very large clouds replete with lightning, there is no reason to imagine that they will not convey some of their contents to other metallic parts of the building at the same time as to the metal at the top: for though
the

the conductor may be large enough to convey to the ground, from the top, all the lightning that enters that part; yet one such small conductor cannot be supposed to exhaust those immense bodies so quickly, as to disable them from striking at the same time other buildings, or other parts of the same building.

A wire, or very small rod of metal, does not seem to be a canal sufficiently large to conduct so great a quantity of lightning to the earth; especially when any part of it, or of the metal communicating with it, is enclosed in the stone work: in which case, the application of it would tend to increase its bad effects, by conducting it to parts of the building which it might otherwise not have reached.

Dr. Franklyn, from observing that the filleting of gold leaf on the cover of a book conducted the charge of five large jars, reasons that a wire will be sufficient to conduct the lightning from the highest buildings to the earth.

But it appears from an experiment of his own, that a much larger body of metal, when inclosed between small plates of thick looking glass, is not sufficient to conduct a fifth part of such a charge, without being melted, and bursting to pieces the plates of glass.

And it is remarkable, that in those parts of the church where the effects of the lightning are most conspicuous, the iron was inclosed in a resisting substance similar to the glass surrounding the gold leaf in that experiment.

Wires, instead of conducting the lightning, have frequently been melted by the explosion. So that,

I think, a conductor of metal less than six or eight inches in breadth, and a quarter of an inch in thickness (or an equal quantity of metal in any other form that may be found more convenient) cannot with safety be depended on, where buildings are exposed to the reception of so great a quantity of lightning. These are the only points in which I have ventured to differ from Dr. Franklyn.

I shall not think my time ill employed, if these observations contribute to our security against the effects of lightning. Certainly an inquiry into the properties of the electric fluid, as it furnishes us with the means of preventing such accidents, is far from being an useless speculation. I am,

Sir,

your most humble servant,

Old Palace Yard,
June 28, 1764.

Edward Delaval.

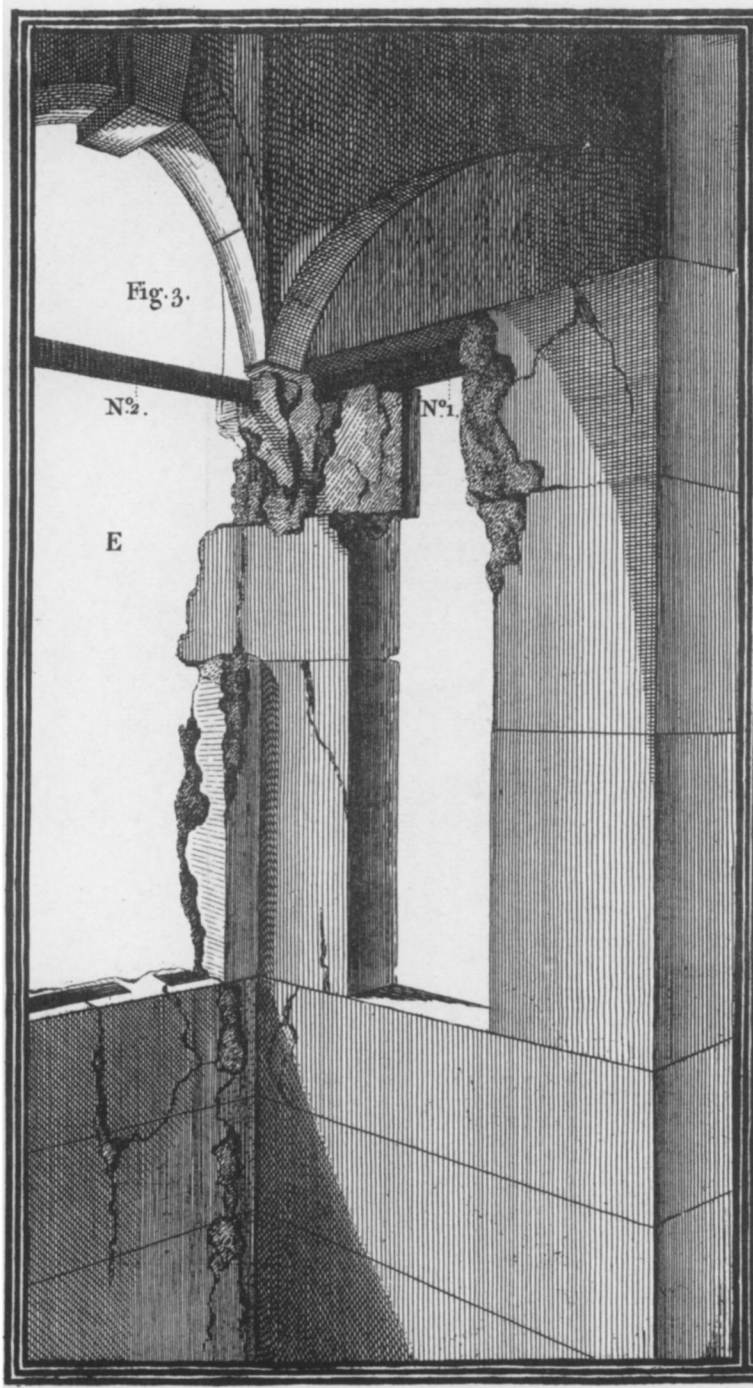


Fig. 2.

